

Refining the Role of Processing in Food Classification Systems:

The IUFoST Formulation & Processing Classification (IF&PC) Approach

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IUFoST
Task Force



EFFoST

12-14 November
Bruges, Belgium



2024

**INTERNATIONAL
CONFERENCE**



IUFoST taskforce approach for consensual classification of processed food products

1. Summary of NOVA classification analysis

- 1.1 Identification of NOVA key issues
- 1.2 Conclusions for task force approach in the NOVA context

2. Differentiation and Quantification of Formulation & Process Impacts on Nutrition Value

- 2.1 Definitions of Formulation and Processing
- 2.2 Causal differentiation of Formulation versus Processing

3. The IUFoST Formulation & Processing Classification (IF&PC) scheme

- 3.1 Classification procedure and target food property quantification
- 3.2 Quantification of F & P impacts on the nutrition value
- 3.3 The Classification Matrix Diagram (CMD)
- 3.4 Extensibility of the IF&PC scheme
- 3.5 Derivation of NOVA refinement suggestions
- 3.6 Transferability of IF&PC scheme for various food properties

4. Summary / Task Force Recommendations and Outlook



Additives Refined Emulsifiers
 Diabetes Artificial Health Starch
ULTRA-PROCESSED
 Snacks **FOODS** Ingredients
 Dietitians ^{Data} Convenience
^{Research} Addiction Preservatives
Addiction Heart Disease Lifestyle
 Packaged **Condiments** Cheap
 Supermarket Obesity Salt Dessert
 Shelf-Life **Hyper-Palatable** Fast Food

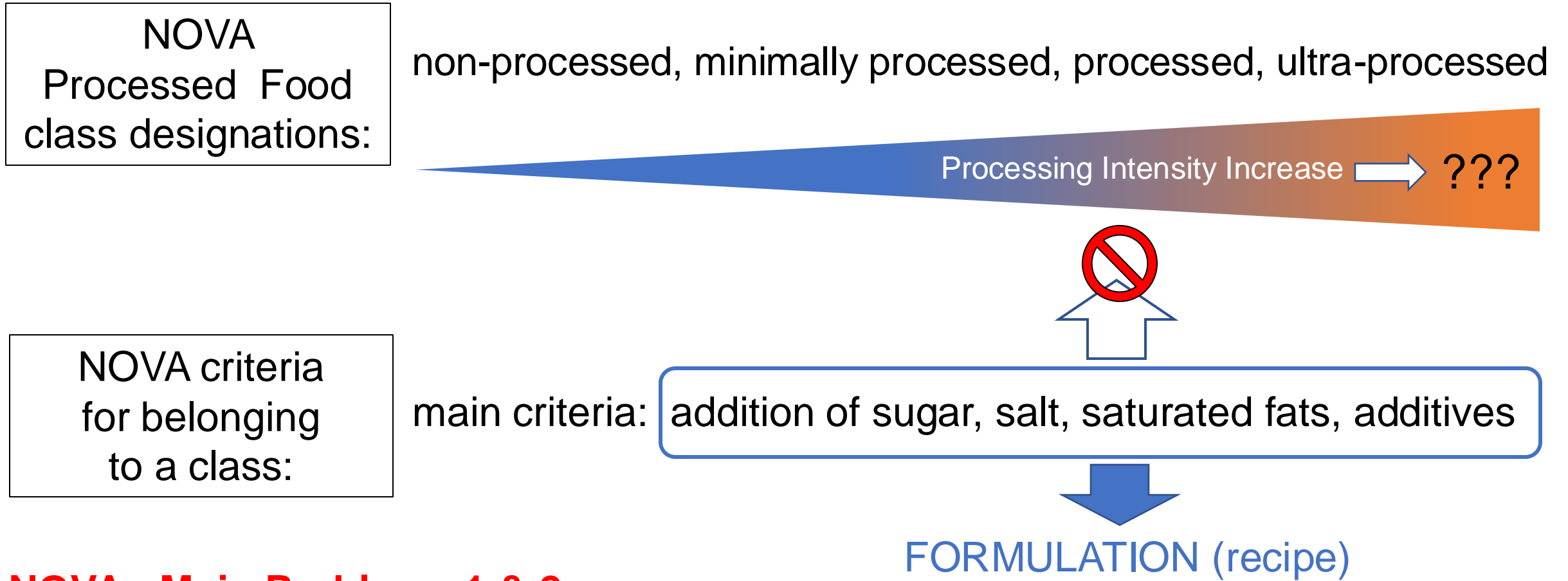
Cancer

Cereal

Sugar

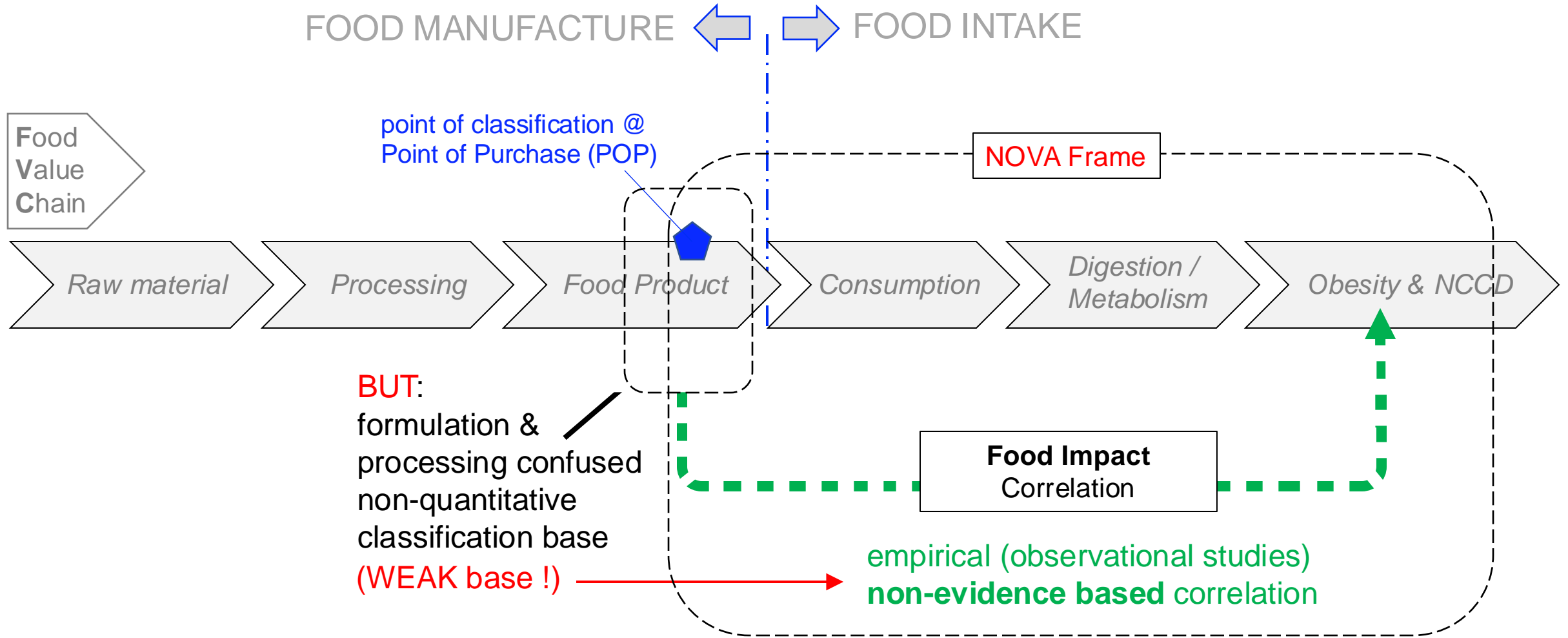
UPF

NOVA Classification System – (C. Monteiro et al. 2010)



NOVA - Main Problems 1 & 2 :

Confusion of Formulation (F) & Processing (P) and missing quantification of F & P



NOVA - Main Problem 3: weak correlation of food classification with obesity/NCCD risk



The following **differentiating DEFINITIONS** were decided by the task force:

Formulation (F) :

“Systematic selection of relative quantities of ingredients for a food product”

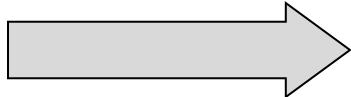
Processing (P) :

“Treatment of a food material to achieve a desired effect”

Processing is targeted to product property generation by structure modulation

- Processing Principles
- Unit Operations

FORMULATION

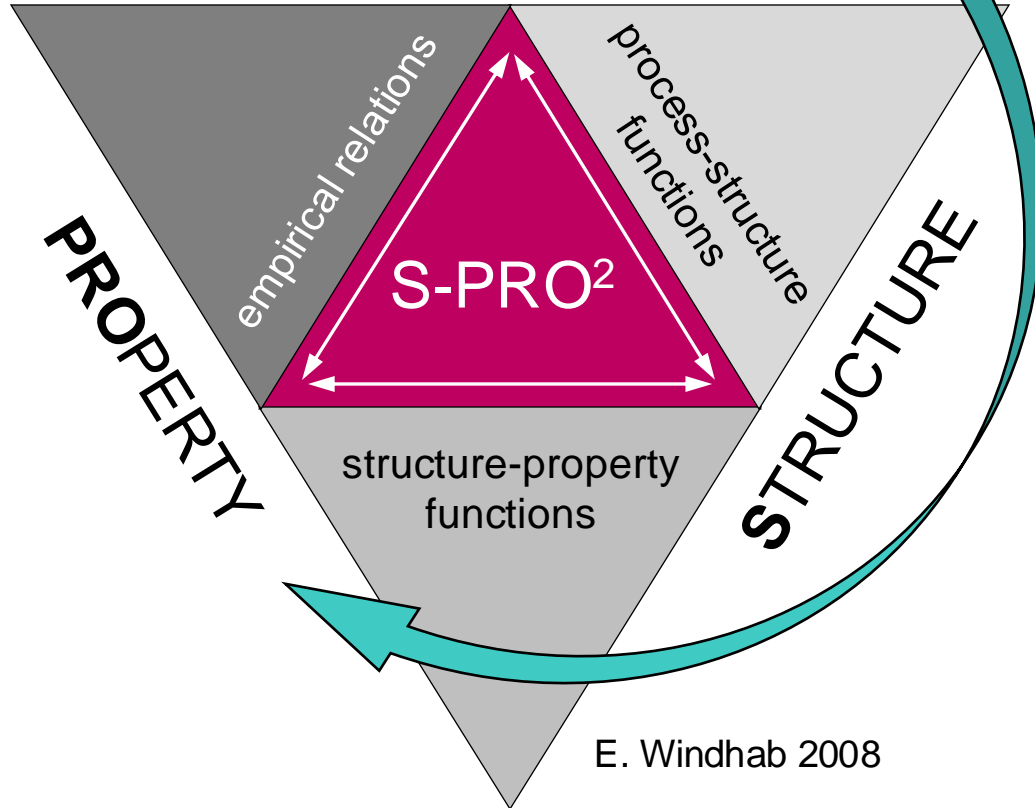


PROCESS

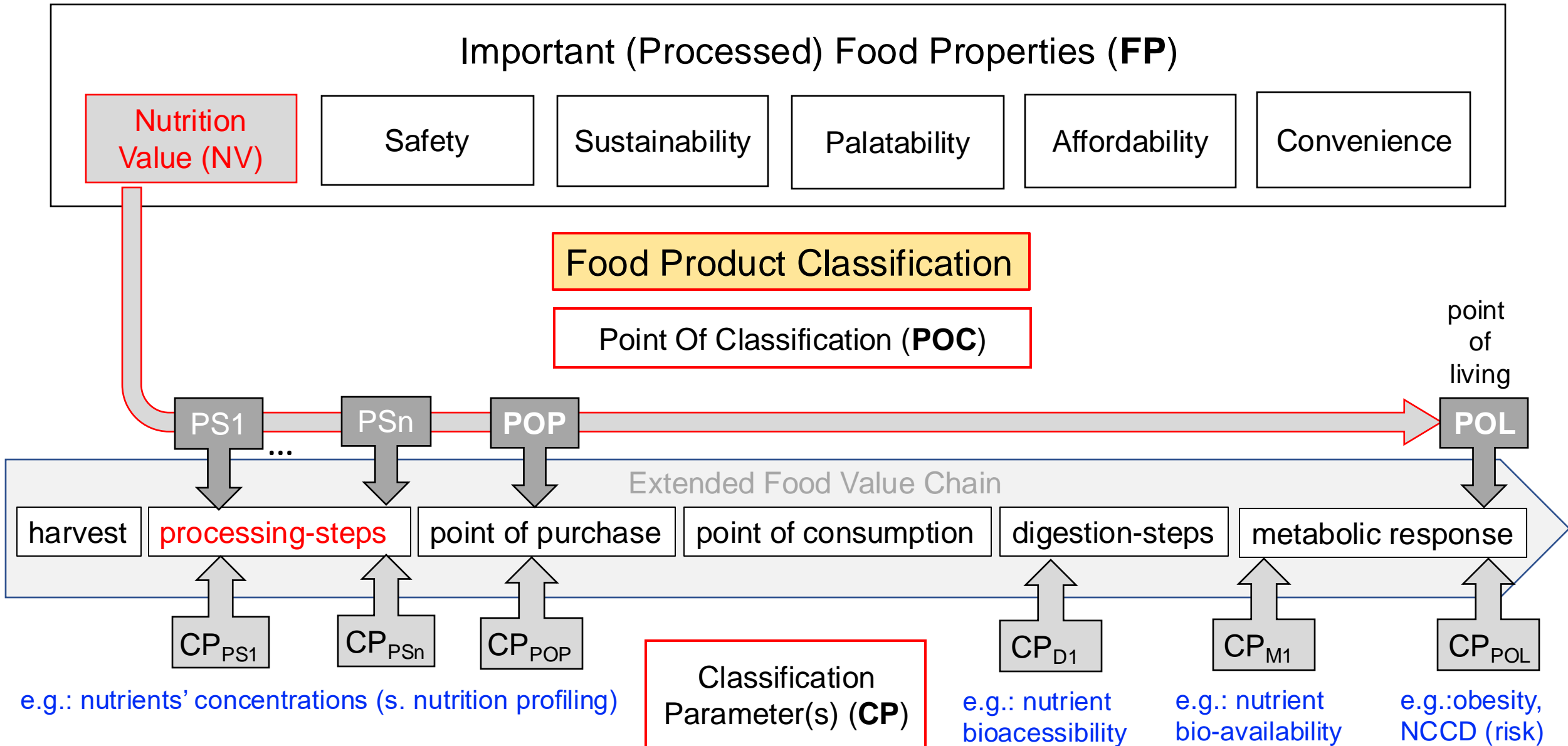
PROCESS ENGINEERING TRACK

PROcess makes Structure; Structure encodes PROperties

- CONSUMER aspects
 - Preference (sensory, convenience)
 - Acceptance (safety, affordability /price, sustainability other socio-political aspects)
 - Needs (nutrition and health)
- => Consumer PAN profile



- Hierarchic arrangement of structure building blocks
 - on molecular to macro length scales
 - within characteristic time scales determining structuring kinetics



$$NR9_{100\text{ kcal}} = \sum_{1-9} (m_{\text{nutrient } i} / m_{DVi}) / S_i \cdot 100$$

$$LIM3_{100\text{ kcal}} = \sum_{1-3} (m_{\text{nutrient } i} / m_{MAVi}) / S_i \cdot 100$$

m_{DVi} = mass of Daily Value

m_{MAVi} = maximum accepted value

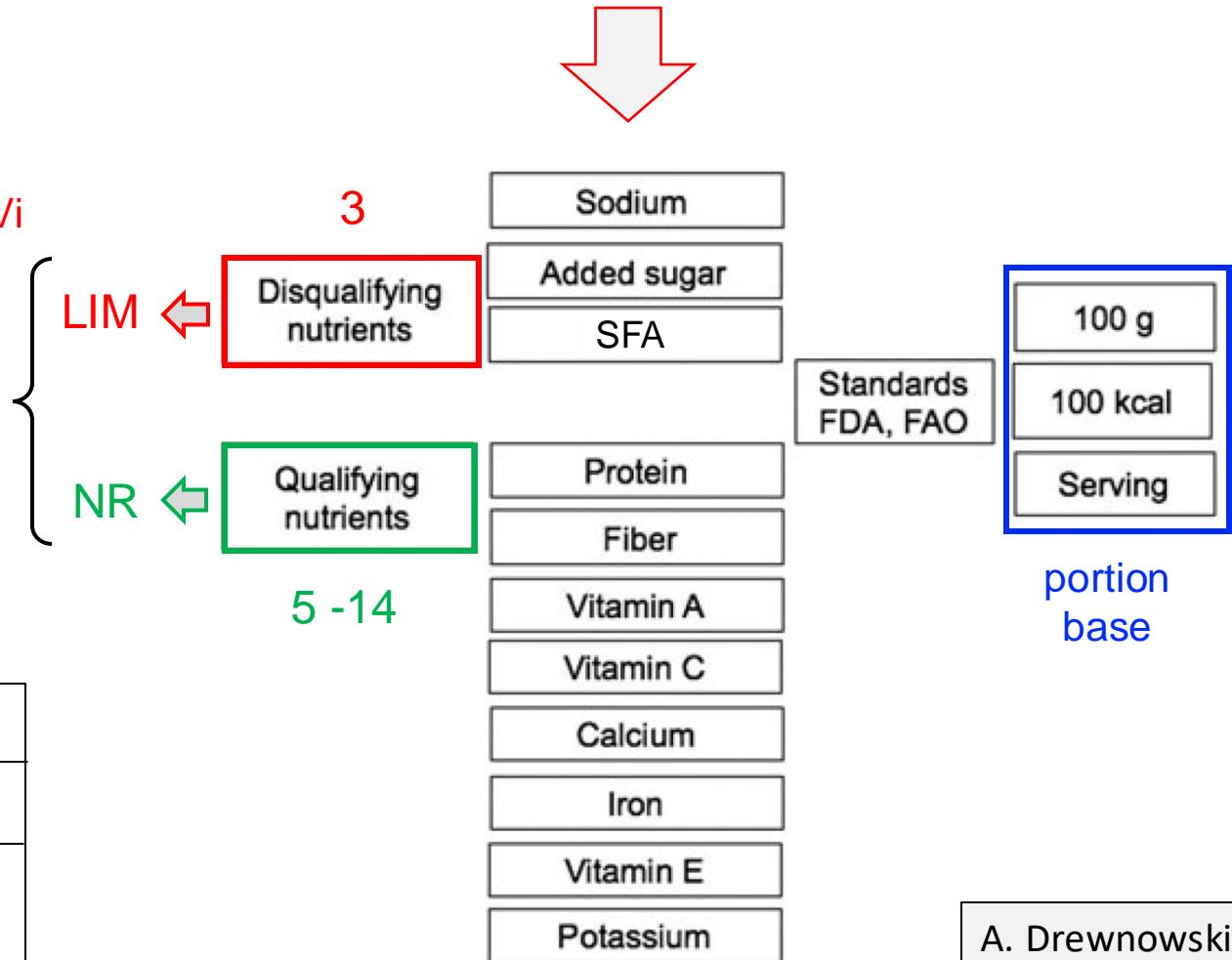
$$\sum m_i / m_{DVi} \quad \sum m_i / m_{MAVi}$$

e.g. **NRF9.3**_{100kcal}

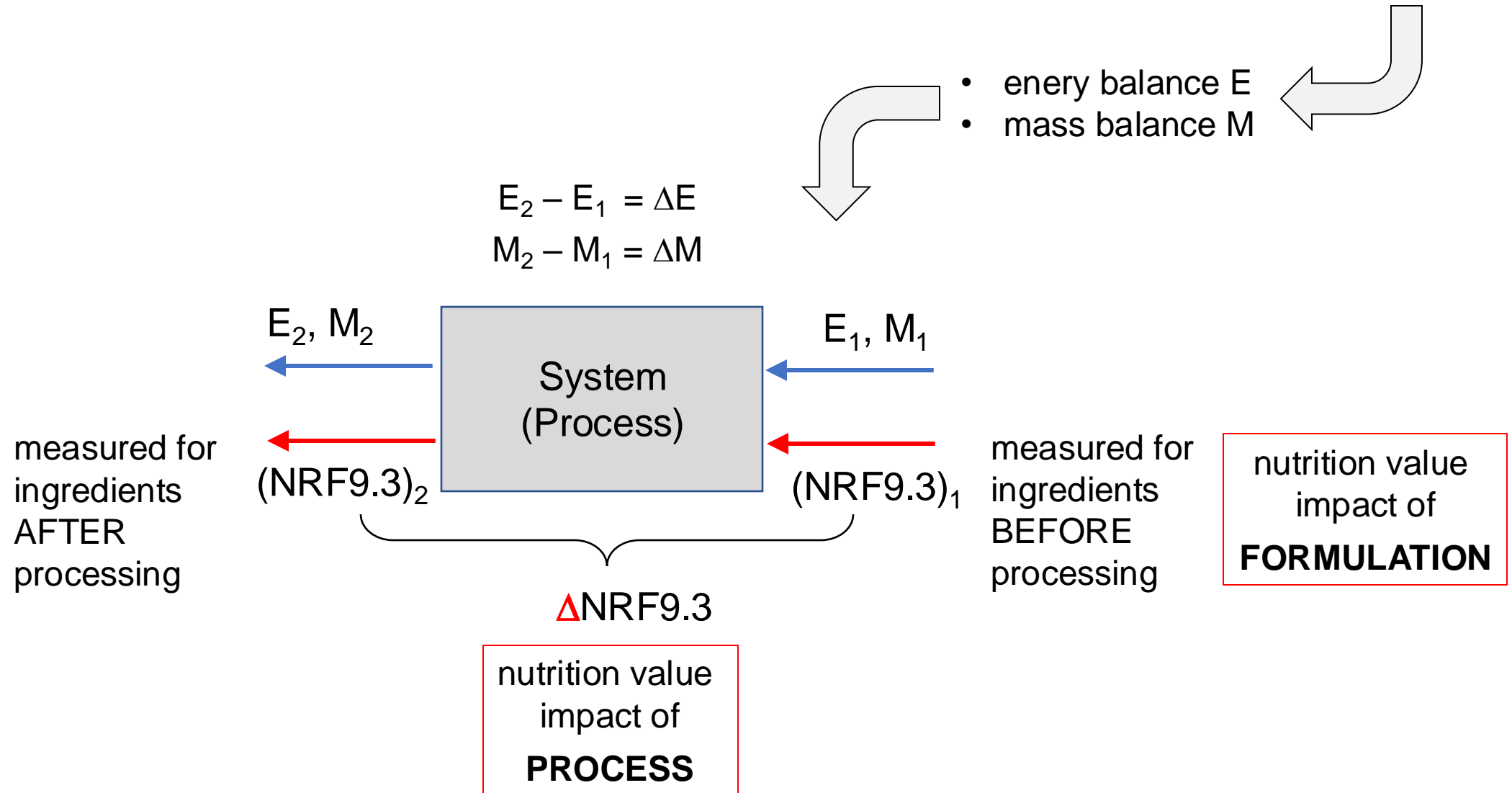
= **NR9** - **LIM3**

Nutrition Value Quantification by Nutrition Profiling Methods

e.g.: (1) Nutri-Score (France), (2) Health Star Rating (AUS, NZL), (3) **Nutrient Rich Food Index (NRF)**



Range:	ca. -200 to +300
Properties:	adaptability (flexibel)
Coupling:	energy density, nutrient density, costs,...

PROCESS ANALYSIS: (Quasi-) Equilibrium considerations & **Analyses by balance equations**

1. Defining the FORMULATION-based Nutrition Value

$$\text{NRF9.3}_{100 \text{ kcal}} = \text{NR9}_{100 \text{ kcal}} - \text{LIM}_{100 \text{ kcal}}$$

- (i) $\text{NR9}_{100 \text{ kcal}} = \sum_{1-9} (m_{\text{nutrient } i} / m_{\text{DVi}}) / S_i \cdot 100$
denoting 9 nutrients recommended per serving (weight), m_{DVi} = mass of Daily Value (nutrient i), S_i = calories per serving
- (ii) $\text{LIM3}_{100 \text{ kcal}} = \sum_{1-3} (m_{\text{nutrient } i} / m_{\text{MRVi}}) / S_i \cdot 100$
denoting (3) nutrients to be limited per serving (weight); m_{MRVi} = mass of maximum recommended value (nutrient i)

2. Defining the PROCESSING-based impact on the Nutrition Value

$$\Delta \text{NRF}_{x.y} = \text{NRF}_{x.y} \text{ after processing} - \text{NRF}_{x.y} \text{ before processing}$$

3. Coupling of NRF & Δ NRF:

Constituting the nutrition value related **Formulation and Processing Food Index FPFIN**

$$\text{FPFI}^{\text{N}} = [(\text{NRF9.3}_1 + 2\Delta \text{NRF9.3}) / A] - B$$

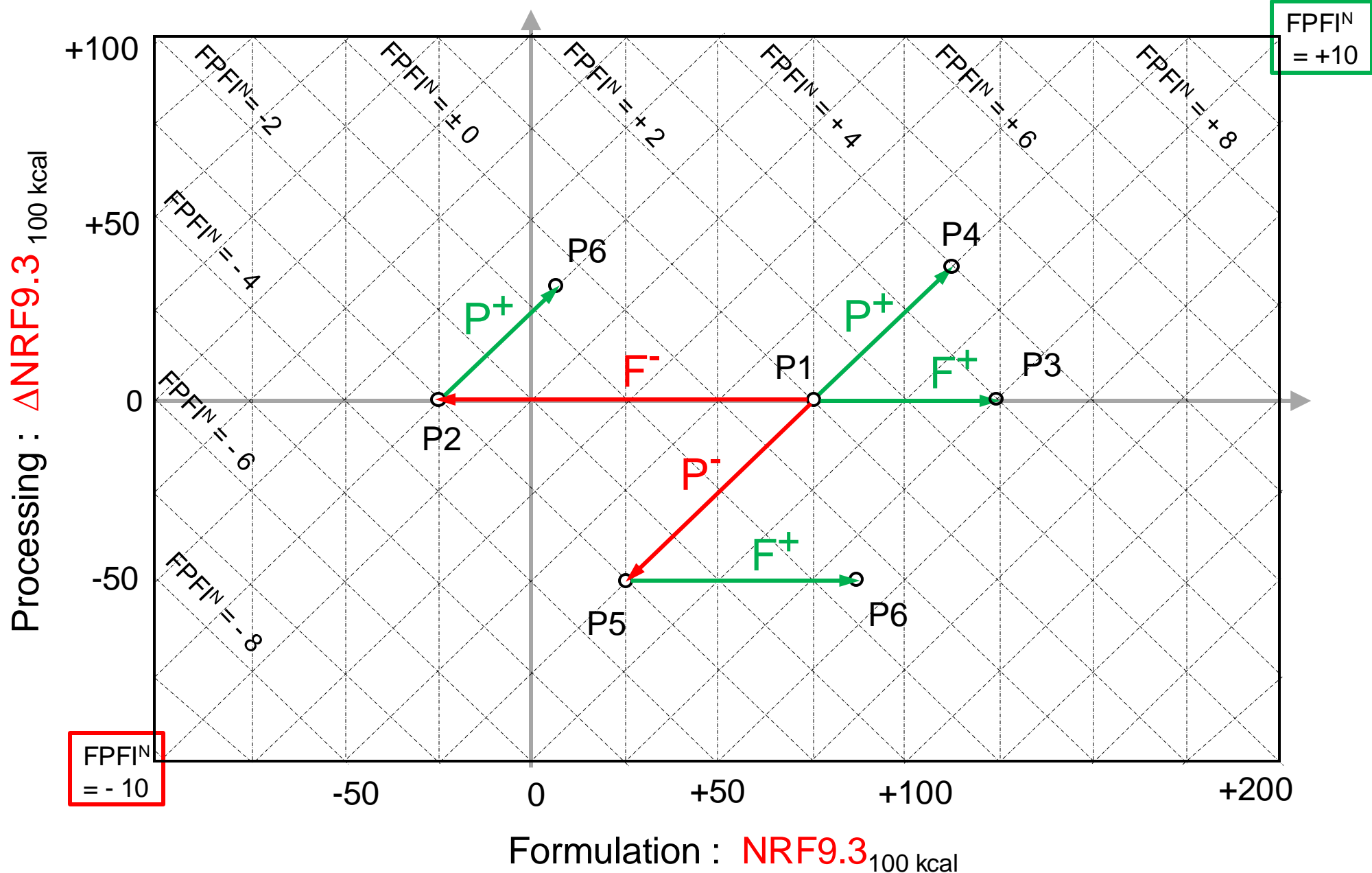
A, B = scaling constants adjustable to the Classification Matrix Diagramm (CMD) suggested for graphical representation

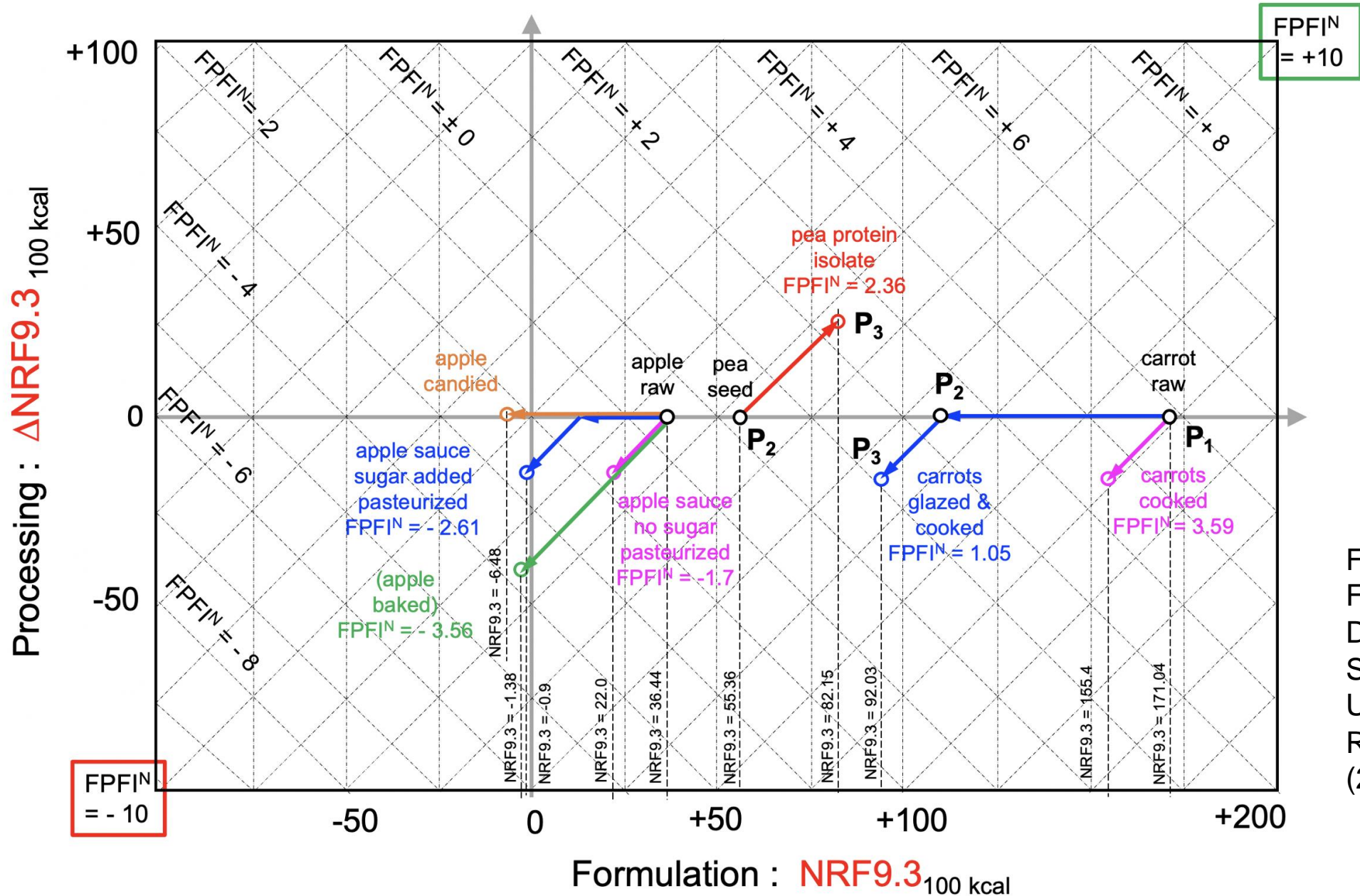


Classification Matrix Diagram (CMD)

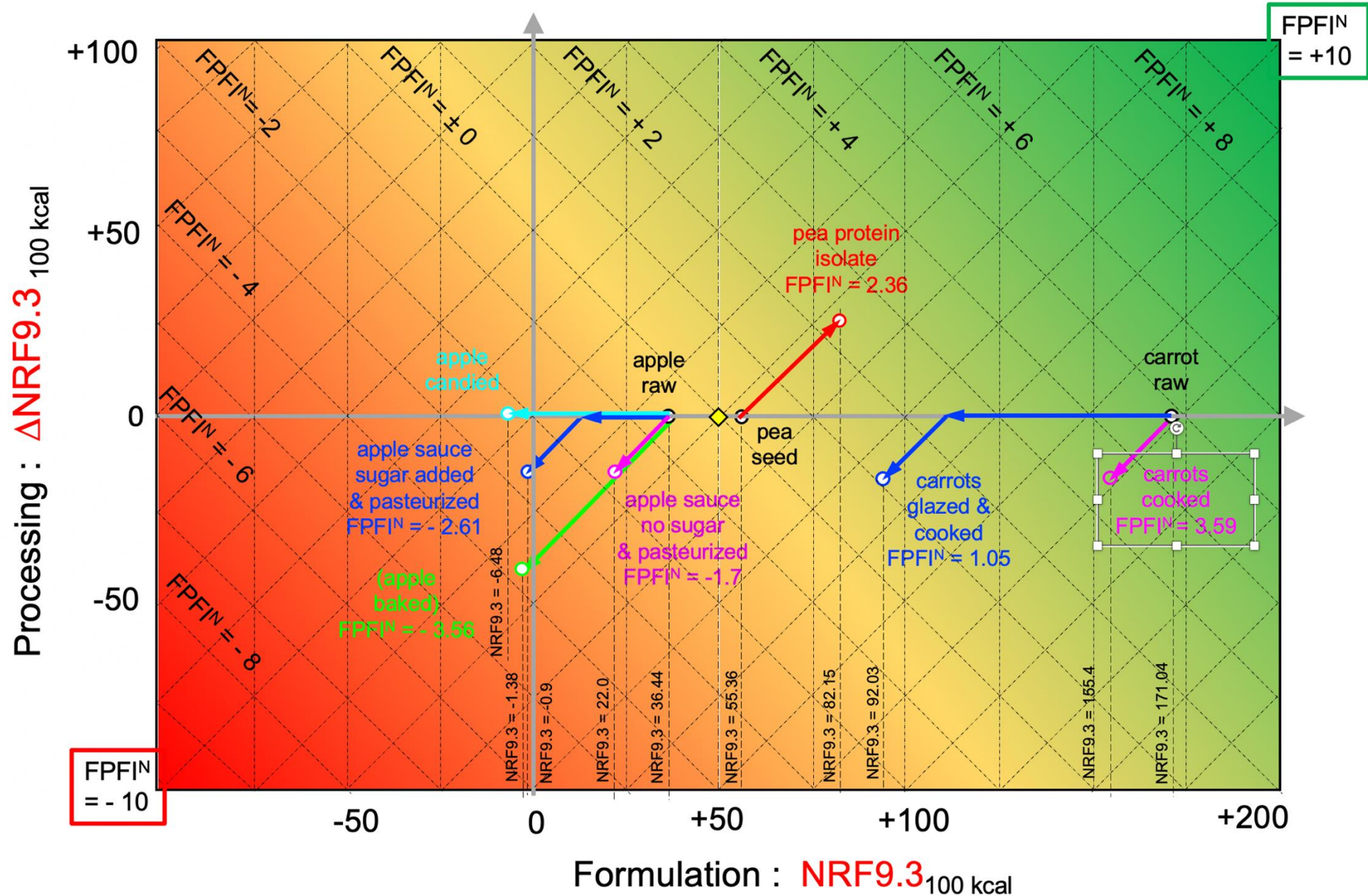
for two-dimensional and recoupled one-dimensional classification representation

- horizontal lines:** \pm formulation impact
- inclined lines (45°):** \pm processing impact
- green:** improvements
- red:** deteriorations





Food product data:
 Food and Nutrient
 Data Base for Dietary
 Studies (FNDDS);
 USDA Agricultural
 Research Service
 (2023 /24)



Consideration of **Anti-Nutrients** (e.g. phytate / phytic acid,...)

$$ANz_{100 \text{ kcal}} = \sum_{1-z} (m_{\text{antinutrient } i} / m_{MTi}) / S_i \cdot 100$$

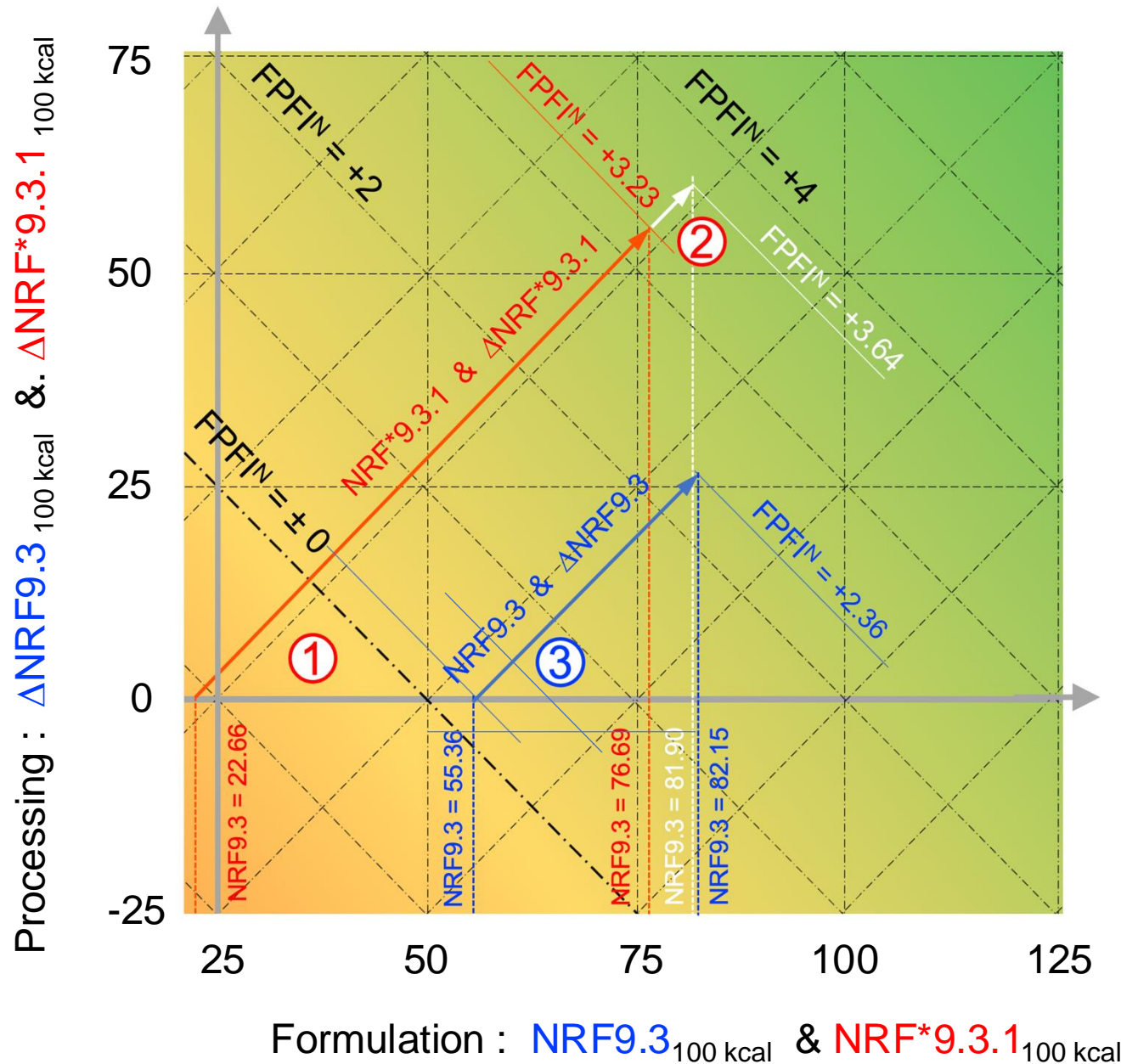
were m_{MTi} denotes the maximum tolerated mass of the considered anti-nutrient and S_i stands for calories / 100g portion

FORMULATION:

$$NRF^{*x.y.z}_{100\text{kcal}} = NR^{*x}_{100\text{kcal}} - LIM^{*y}_{100\text{kcal}} - AN^{*z}_{100\text{kcal}}$$

PROCESSING:

$$\Delta NRF^{*x.y.z}_{100\text{kcal}} = \Delta NR^{*x}_{100\text{kcal}} - \Delta LIM^{*y}_{100\text{kcal}} - \Delta AN^{*z}_{100\text{kcal}}$$

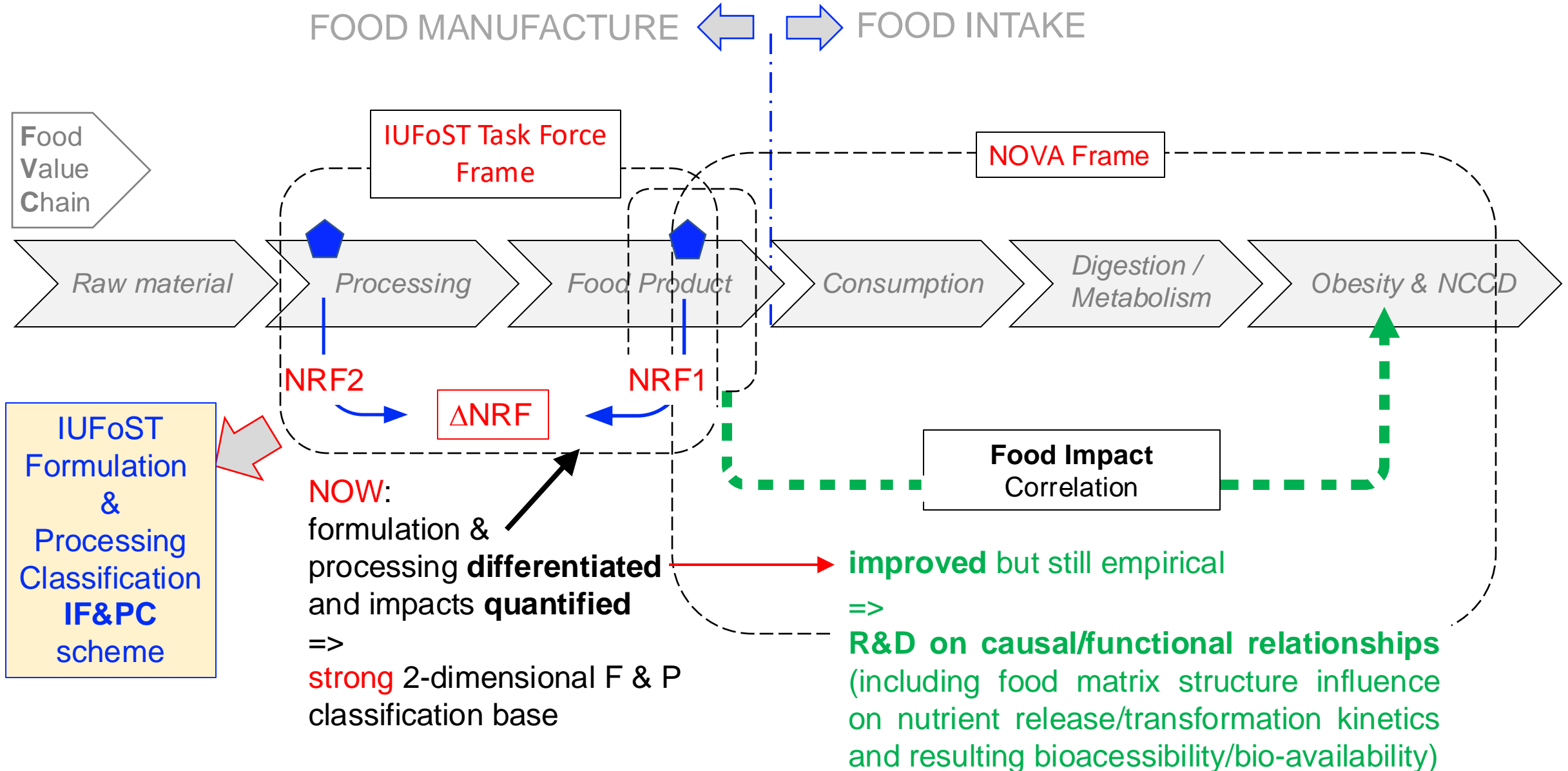


Example: Phytate inactivation

Formulation (material):
 pea seeds => pea protein isolate
 (e.g. for meat alternative production)

Processes:

- (1) alk. extraction / precipitation
 (phytate inactivation considered)
- (2) extrusion & autoclaving
 (phytate inactivation considered)
- (3) alk. extraction / precipitation
 (phytate inactivation not considered)



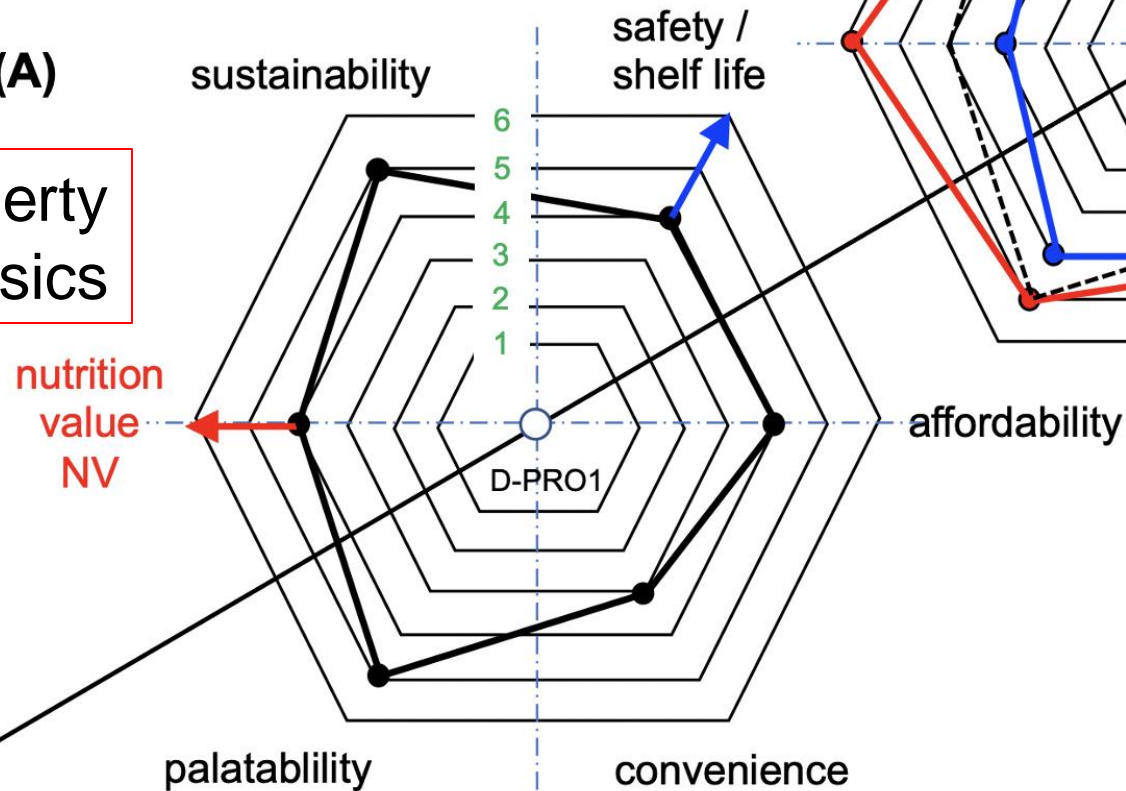
COMPARISON:

Process-Ex1: High pressure pasteurization

Process-Ex2: Thermal Sterilization

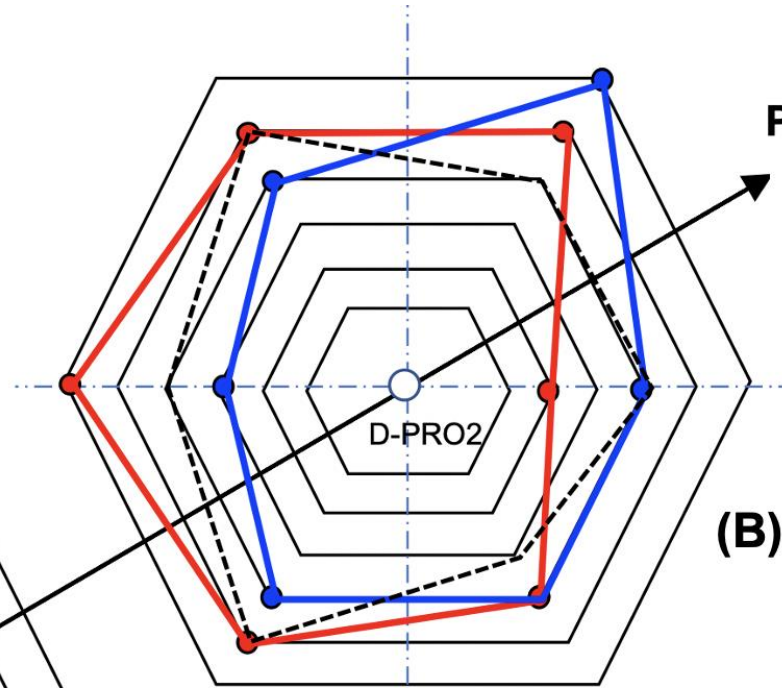
Food Property Characteristics

(A)



Degree of Processing

(B)



- there are several essentially relevant property characteristics of processed food products beside the nutrition value
- optimizing one can mean trade offs for (some of) the others

Nr	Product Property (PP)	Formulation (F)	Processing (P)	F&P Coupling
1	Nutrition Value	e.g. $NRF^{*x.y.z}$	$\Delta NRF^{*x.y.z}$	$FPFI^N$
2	Sustainability	e.g. Global Warming Potential GWP	ΔGWP (Global Warming Potential Difference)	$FPFI^{SU}$
3	Palatability	e.g. Sensory Score SS Energy-/Volume-consumption for satiation EC-Sat or VC-Sat eating/mastication speed ES	ΔSS $\Delta EC-Sat; \Delta VC-Sat$ ΔES_t	$FPFI^{SS}$ $FPFI^{EC-Sat}$ $FPFI^{VC-Sat}$
4	Safety	e.g. Colony Forming Unit (CFU) count	ΔCFU	$FPFI^{CFU}$
5	Convenience	e.g. Convenience Score CS	ΔCS	$FPFI^{CS}$
6	Affordability	e.g. Energy Consumption / \$ or $NRF^{x.y./\$}$; $NRF^{*x.y.z/\$}$	$\Delta EC\$$ $\Delta NRF/\$; \Delta NRF^{*}/\$$	$FPFI^{EC\$}$ $FPFI^{NRF\$}$ $FPFI^{NRF^{*}\$}$
7	Digestibility: e.g. for proteins further static or dynamic (future) INFOGEST	e.g. PDCAAS* DIAAS**	$\Delta PDCAAS$ $\Delta DIAAS$	$FPFI^{PDCAAS}$ $FPFI^{DIAAS}$
8	(IG) parameters $P_1 \dots P_N$	e.g. IG-Pi	$\Delta IG-Pi$	$FPFI^{IGPi}$



- (a) Systematic studies should consider **interactions between food components / ingredients and processes** and quantify NRF and Δ_R NRF values systematically following the IF&PC scheme approach.
- (b) The **IF&PC scheme should be systematically checked and validated** based on various formulation and processing scenarios and modifications / improvements be implemented.
- (c) Complementary studies should look at **interactions between additives and processes and also study eating behaviour and matrix effects** impacting on nutrient release and digestion kinetics.
- (d) A revised definition of “Formulation or Process-Induced Health Risk Foods” needs to **first identify the harmfulness of processing treatments and/or single, specific ingredients** using reliable health biomarkers, and by conducting dose–response relations to identify thresholds.
- (e) An **international balanced panel of experts** from food science/engineering, nutrition, and medicine should be gathered to draft the future IF&PC/NOVA food classification version, and subsequently there should be a hearing phase to receive suggestions for improvements.
- (f) **Close R&D collaborations** between food science, food engineering, biological chemistry, clinical nutrition, public health and toxicology researchers and those involved in regulatory and quality sciences should be encouraged and setup. **IUFOST and IUNS are particularly encouraged** to initiate such collaborations. **FAO, CODEX Alimentarius and UNIDO** should be invited to join.
- (e) Collaborations should **in future also include industrial partners** (food producers, food processing developers, and equipment manufacturers).

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Thank you
QUESTIONS???

for your attention!?



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